CLAIMS

What is claimed is:

1. A method of converting an organometallic precursor material to a metal-containing pattern adherent to a substrate, comprising:

applying the organometallic precursor material in an amount sufficient to coat at least a portion of the substrate, wherein said organometallic precursor material is adapted to be converted to form a metal or metal oxide;

pre-converting the organometallic precursor material by exposing the organometallic precursor material to a pre-conversion energy exposure dose such that the pre-converted precursor material is not converted to a degree sufficient to impair pattern resolution;

pattern converting a portion of the pre-converted precursor material to convert this portion to a pattern-converted material to an extent sufficient to thereby form a pattern on the substrate; and

developing the portion of the pre-converted precursor material that was not pattern-converted such that the pattern remains on the substrate after developing.

2. The method of claim 1, wherein the pattern conversion comprises exposing the pre-converted precursor material to a patterning energy exposure dose, which converts the pre-converted precursor material to metal or metal oxide that adheres to the substrate to an extent sufficient to thereby form a deposited pattern thereon.

3. The method of claim 2, wherein the pre-conversion energy exposure dose is selected to be about 20% or less of the combination of the pre-conversion energy exposure dose and the patterning energy exposure dose, such that the pre-converted precursor material is substantially developable.

4. The method of claim 2, wherein the pre-conversion energy exposure dose is selected to be from about 20% to about 50% of the combination of the pre-conversion energy exposure dose and the patterning energy exposure dose, such that the pre-converted precursor material is substantially developable.

5. The method of claim 1, wherein the pre-conversion, the pattern-conversion, or both, comprises photochemical metal organic deposition.

6. The method of claim 1, wherein the pre-conversion comprises forming a metal or metal oxide within the organometallic precursor material.

7. The method of claim 1, wherein the pre-conversion energy exposure dose is selected to be from about 30% to about 80% of a maximum pre-conversion energy exposure dose, wherein the maximum pre-conversion energy exposure dose is that energy dose above which the organometallic precursor material exposed to the pre-conversion energy exposure dose is no longer substantially developable or above which the organometallic precursor material exposed to the pre-conversion energy exposure dose adheres to the substrate to a degree sufficient to impair pattern resolution, wherein the organometallic precursor material exposed to the pre-conversion energy exposure dose is substantially developable.

8. The method of claim 1, wherein the pre-conversion energy exposure dose is selected to be about 50% or more of a maximum pre-conversion energy exposure dose, wherein the maximum pre-conversion energy exposure dose is that energy dose above which the organometallic precursor material exposed to the pre-conversion energy exposure dose is no longer substantially developable or above which the organometallic precursor material exposed to the pre-conversion energy exposure dose adheres to the substrate to a degree sufficient to impair pattern resolution, wherein the organometallic precursor material exposed to the pre-conversion energy exposure dose is substantially developable.

9. The method of claim 1, wherein the pre-conversion energy exposure dose is selected to be from about 60% to about 99% of a maximum pre-conversion energy exposure dose, wherein the maximum pre-conversion energy exposure dose is that energy dose above which the organometallic precursor material exposed to the pre-conversion energy exposure dose is no longer substantially developable or above which the organometallic precursor material exposed to the pre-conversion energy exposure dose adheres to the substrate to a degree sufficient to impair pattern resolution, wherein the organometallic precursor material exposed to the pre-conversion energy exposure dose is substantially developable.

10. A substrate containing a patterned metal or metal oxide layer formed according to the method of claim 1.

11. The method according to claim 1, wherein the pre-conversion comprises exposing the precursor material to a heat source, and wherein the pattern-conversion comprises exposing the pre-converted precursor material to a light source.

12. The method according to claim 1, wherein the pre-conversion comprises exposing the precursor material to a heat source, and wherein the pattern-conversion comprises exposing the pre-converted precursor material to an electron-beam source.

13. The method according to claim 1, wherein the pre-conversion comprises exposing the precursor material to an electron-beam source, and wherein the pattern-conversion comprises exposing the pre-converted precursor material to a light source.

14. The method according to claim 1, wherein the pre-conversion comprises exposing the precursor material to a light source, and wherein the pattern-conversion comprises exposing the pre-converted precursor material to a light source.

15. A method of converting an organometallic precursor material to a metal-containing pattern adherent to a substrate, comprising:

applying the organometallic precursor material in an amount sufficient to coat at least a portion of the substrate, wherein said organometallic precursor material is adapted to be converted to form a metal or metal oxide;

pre-converting the organometallic precursor material by exposing the organometallic precursor material to a pre-conversion energy exposure dose such that the pre-converted precursor material is not converted to a degree sufficient to impair pattern resolution;

pattern converting a first portion of the pre-converted precursor material to convert this portion to a pattern-converted material to an extent sufficient to thereby form a first pattern on the substrate;

pattern converting a second portion of the pre-converted precursor material to convert this portion to a pattern-converted material an extent sufficient to thereby form a second pattern on the substrate; and

developing the second portion of the pre-converted precursor material that was pattern-converted such that the second pattern remains on the substrate after developing.

16. The method of claim 15, wherein the pattern conversion comprises exposing the pre-converted precursor material to a patterning energy exposure dose, which converts the pre-converted precursor material to metal or metal oxide that adheres to the substrate to an extent sufficient to thereby form a deposited pattern thereon.

17. The method of claim 16, wherein the pre-conversion energy exposure dose is selected to be about 20% or less of the combination of the pre-conversion energy exposure dose and the patterning energy exposure dose, such that the pre-converted precursor material is substantially developable.

18. The method of claim 16, wherein the pre-conversion energy exposure dose is selected to be from about 20% to about 50% of the combination of the pre-conversion energy exposure dose and the patterning energy exposure dose, such that the pre-converted precursor material is substantially developable.

19. The method of claim 15, wherein the pre-conversion, the pattern-conversion, or both, comprises photochemical metal organic deposition.

20. The method of claim 15, wherein the pre-conversion comprises forming a metal or metal oxide within the organometallic precursor material.

21. The method of claim 15, wherein the pre-conversion energy exposure dose is selected to be from about 30% to about 80% of a maximum pre-conversion energy exposure dose, wherein the maximum pre-conversion energy exposure dose is that energy dose above which the organometallic precursor material exposed to the pre-conversion energy exposure dose is no longer substantially developable or above which the organometallic precursor material exposed to the pre-conversion energy exposure dose adheres to the substrate to a degree sufficient to impair pattern resolution, wherein the organometallic precursor material exposed to the pre-conversion energy exposure dose is substantially developable.

22. The method of claim 15, wherein the pre-conversion energy exposure dose is selected to be about 50% or more of a maximum pre-conversion energy exposure dose, wherein the maximum pre-conversion energy exposure dose is that energy dose above which the organometallic precursor material exposed to the pre-conversion energy exposure dose is no longer substantially developable or above which the organometallic precursor material exposed to the pre-conversion energy exposure dose adheres to the substrate to a degree sufficient to impair pattern resolution, wherein the organometallic precursor material exposed to the pre-conversion energy exposure dose is substantially developable.

23. The method of claim 15, wherein the pre-conversion energy exposure dose is selected to be from about 60% to about 99% of a maximum pre-conversion energy exposure dose, wherein the maximum pre-conversion energy exposure dose is that energy dose above which the organometallic precursor material exposed to the pre-conversion energy exposure dose is no longer substantially developable or above which the organometallic precursor material exposed to the pre-conversion energy exposure dose adheres to the substrate to a degree sufficient to impair pattern resolution, wherein the organometallic precursor material exposed to the pre-conversion energy exposure dose is substantially developable.

24. A substrate containing a patterned metal or metal oxide layer formed according to the method of claim 15.

25. The method according to claim 15, wherein the pre-conversion comprises exposing the precursor material to a heat source, and wherein the pattern-conversion comprises exposing the pre-converted precursor material to a light source.

26. The method according to claim 15, wherein the pre-conversion comprises exposing the precursor material to a heat source, and wherein the pattern-conversion comprises exposing the pre-converted precursor material to an electron-beam source.

27. The method according to claim 15, wherein the pre-conversion comprises exposing the precursor material to an electron-beam source, and wherein the pattern-conversion comprises exposing the pre-converted precursor material to a light source.

28. The method according to claim 15, wherein the pre-conversion comprises exposing the precursor material to a light source, and wherein the pattern-conversion comprises exposing the pre-converted precursor material to a light source.

29. An apparatus for converting an organometallic precursor material to a metal-containing film adherent to a substrate formed by a method according to claim 1, comprising:

a load station to store the substrate before processing;

a means of delivering the substrate between processing steps;

a pre-convert section, wherein the substrate is coated, if previously uncoated, with a sufficient amount of the organometallic precursor material and is subjected to a first converting means in either a series or parallel arrangement;

a pattern convert section, wherein the organometallic precursor material coated on the substrate, subjected to a first converting means, and not covered by a mask is substantially converted, using a second converting means, to form a metal-containing pattern adherent to the substrate; and

an unload station where the pattern-coated substrate is stored after processing.

30. The apparatus of claim 29, wherein the first and second converting means are the same or different, and wherein each comprises a heat source, a light source, a coherent light source, a broadband light source, an electron beam source, or an ion beam source.

31. An apparatus for converting an organometallic precursor material to a metal-containing film adherent to a substrate formed by a method according to claim 15, comprising:

a load station to store the substrate before processing;

a means of delivering the substrate between processing steps;

a pre-convert section, wherein the substrate is coated, if previously uncoated, with a sufficient amount of the organometallic precursor material and is subjected to a first converting means in either a series or parallel arrangement;

a pattern convert section, wherein the organometallic precursor material coated on the substrate, subjected to a first converting means, and not covered by a mask is

substantially converted, using a second converting means, to form a metal-containing pattern adherent to the substrate; and

an unload station where the pattern-coated substrate is stored after processing.

32. The apparatus of claim 31, wherein the first and second converting means are the same or different, and wherein each comprises a heat source, a light source, a coherent light source, a broadband light source, an electron beam source, or an ion beam source.

33. A method of selecting a pre-conversion energy exposure dose and a patterning energy exposure dose to be used in converting an organometallic precursor material to a metal-containing patterned layer comprising at least two pattern elements that are adherent to a substrate, which method comprises:

determining a relationship between the pre-conversion energy exposure dose in the conversion and the amount of pre-converted precursor material that adheres to the substrate; and

selecting a pre-conversion energy exposure dose that is less than a maximum pre-conversion energy exposure dose, wherein the maximum pre-conversion energy exposure dose is that energy dose above which the organometallic precursor material exposed to the pre-conversion energy exposure dose is no longer substantially developable or above which the organometallic precursor material exposed to the pre-conversion energy exposure dose adheres to the substrate to a degree sufficient to impair pattern resolution, such that the patterning energy exposure dose yields an acceptable pattern resolution on the substrate,

wherein the acceptable pattern resolution is such that the at least two elements of the metal-containing patterned layer are discrete and not connected by like material.

34. The method of claim 33, further comprising identifying a maximum pre-conversion energy exposure dose based on the dose-conversion relationship, such that the organometallic precursor material exposed to the pre-conversion energy exposure dose, but not to the patterning energy exposure dose is substantially removable during developing.

35. The method of claim 33, wherein the pre-conversion energy exposure dose is selected to be about 20% or less of the combination of the pre-conversion energy exposure dose and the patterning energy exposure dose, such that the pre-converted precursor material is substantially developable.

36. The method of claim 33, wherein the pre-conversion energy exposure dose is selected to be from about 20% to about 50% of the combination of the pre-conversion energy exposure dose and the patterning energy exposure dose, such that the pre-converted precursor material is substantially developable.

37. The method of claim 33, wherein the pre-conversion energy exposure dose is selected to be from about 30% to about 80% of a maximum pre-conversion energy exposure dose, wherein the maximum pre-conversion energy exposure dose is that energy dose above which the organometallic precursor material exposed to the pre-conversion energy exposure dose is no longer substantially developable or above which the organometallic precursor material exposed to the pre-conversion energy exposure dose adheres to the substrate to a degree sufficient to impair pattern resolution, wherein the organometallic precursor material exposed to the pre-conversion energy exposure dose is substantially developable.

38. The method of claim 33, wherein the pre-conversion energy exposure dose is selected to be about 50% or more of a maximum pre-conversion energy exposure dose, wherein the maximum pre-conversion energy exposure dose is that energy dose above which the organometallic precursor material exposed to the pre-conversion energy exposure dose is no longer substantially developable or above which the organometallic precursor material exposed to the pre-conversion energy exposure dose adheres to the substrate to a degree sufficient to impair pattern resolution, wherein the organometallic precursor material exposed to the pre-conversion energy exposure dose is substantially developable.

39. The method of claim 33, wherein the pre-conversion energy exposure dose is selected to be from about 60% to about 99% of a maximum pre-conversion energy exposure dose, wherein the maximum pre-conversion energy exposure dose is that energy dose above which the organometallic precursor material exposed to the pre-conversion energy exposure dose is no longer substantially developable or above which the organometallic precursor material exposed to the pre-conversion energy exposure dose

adheres to the substrate to a degree sufficient to impair pattern resolution, wherein the organometallic precursor material exposed to the pre-conversion energy exposure dose is substantially developable.